

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 10 July 2001 (10.07.01)	
International application No. PCT/EP00/10104	Applicant's or agent's file reference 129185
International filing date (day/month/year) 02 October 2000 (02.10.00)	Priority date (day/month/year) 05 October 1999 (05.10.99)
Applicant GONZALEZ GONZALEZ, Jorge et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 27 April 2001 (27.04.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Odile ALIU Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

VAN HEESCH, Helmut
Uexküll & Stolberg
Beselerstrasse 4
D-22607 Hamburg
ALLEMAGNE

Date of mailing (day/month/year) 26 April 2002 (26.04.02)	
Applicant's or agent's file reference LP 1868 PCT	IMPORTANT NOTIFICATION
International application No. PCT/EP00/10140	International filing date (day/month/year) 16 October 2000 (16.10.00)

1. The following indications appeared on record concerning: <input type="checkbox"/> the applicant <input type="checkbox"/> the inventor <input checked="" type="checkbox"/> the agent <input type="checkbox"/> the common representative		
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2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:			
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		<input type="checkbox"/> the residence	
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VAN HEESCH, Helmut Uexküll & Stolberg Beselerstrasse 4 D-22607 Hamburg Germany		Telephone No. 040 899 654-0	
		Facsimile No. 040 899 654 88	
		Teleprinter No.	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

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<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input type="checkbox"/> the International Preliminary Examining Authority	<input checked="" type="checkbox"/> other: RIEGLER, Norbert, Hermann

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Name and Address VAN HEESCH, Helmut Uexküll & Stolberg Beselerstrasse 4 D-22607 Hamburg Germany	<table border="1"> <tr> <td>State of Nationality</td> <td>State of Residence</td> </tr> <tr> <td colspan="2">Telephone No. 040 899 654-0</td> </tr> <tr> <td colspan="2">Facsimile No. 040 899 654 88</td> </tr> <tr> <td colspan="2">Teleprinter No.</td> </tr> </table>	State of Nationality	State of Residence	Telephone No. 040 899 654-0		Facsimile No. 040 899 654 88		Teleprinter No.	
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The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Anne KARKACHI Telephone No.: (41-22) 338.83.38
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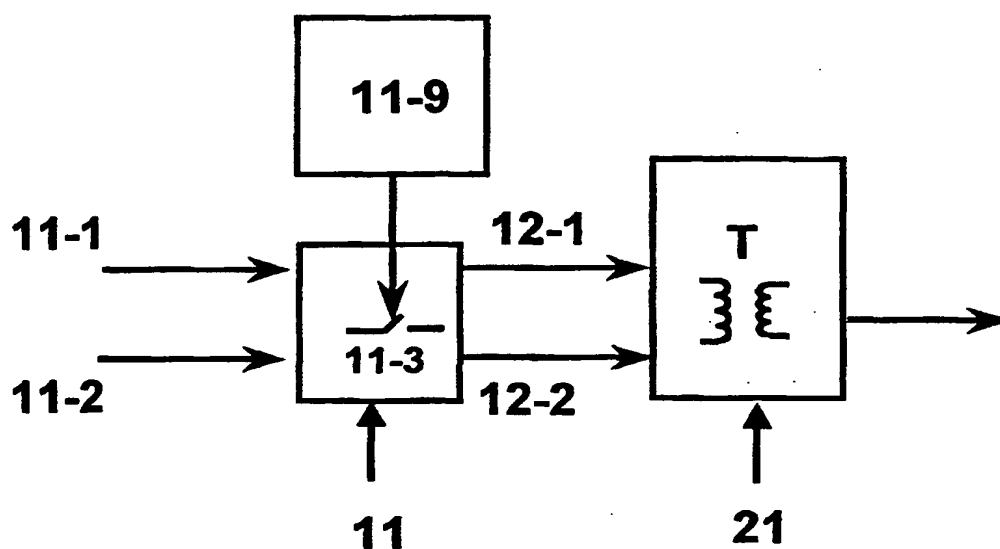
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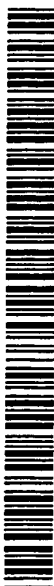
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*For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.*

(54) Title: **SWITCHED POWER SUPPLY CONVERTER FOR BROAD RANGE OF INPUT VOLTAGES**



(57) Abstract: Switched power supply converter for broad range of input voltages that comprises a first stage (11) connected in cascade with a second stage (21), such that a first voltage supplied from a voltage source is converted into a second voltage by means of a first switching element (11-3). The second voltage is transformed into a third DC voltage by the operation of the second stage (21). A control circuit (11-9) controls the duty cycle of the first switching element (11-3) so that the duty cycle varies between a first limit and a second limit of the duty cycle when the first voltage lies within a predetermined voltage range. The control circuit (11-9) sets the duty cycle to the first limit of the duty cycle or to the second limit of the duty cycle in the event of the first voltage being outside the predetermined range of voltage values.



WO 01/26208 A1

SWITCHED POWER SUPPLY CONVERTER FOR BROAD RANGE OF INPUT VOLTAGES

OBJECT OF THE INVENTION

5 The present invention relates to a switched power supply converter that comprises at least one switching element with which the transfer of energy between the input and the output of the power supply converter is governed.

The switching element is controlled so that its duty cycle is at all times a function of the value of the output voltage, whereby the power supply
10 converter offers a high efficiency over a universal range of input voltages.

The switched power supply converter is of special, but not exclusive application in telecommunications systems, which are fed from voltage sources of 38 to 380 V.

STATE OF THE ART

15 A switched power supply converter which has a switching element whose duty cycle is variable and which receives a broad range of input voltages has been described, for example, in the US Patent 5,856,739 granted to A. Trica, incorporated in the present patent application by reference.

20 The switched converter, implemented according to a buck topology, comprises a switching element that has a high switching frequency and a variable duty cycle, an internal control current loop, an external control voltage loop and a control circuit that controls the duty cycle of the switching element as a function of the current loop and of the voltage loop.

25 The power supply converter accepts a broad range of input voltages of up to four times the output voltage. The converter is capable of working in voltage ranges that include voltage values supplied from batteries and from alternating current supply sources. However it is incapable of working with higher ranges, for example 10:1, and providing power levels equal to or
30 greater than 100 W.

It has become necessary to develop a switched power supply converter that accepts a universal range of input voltages, which includes the voltage values supplied normally by the batteries of telecommunications systems, and guarantees for all of them the provision of a constant and
35 regulated voltage at its output, so that the converter offers a high efficiency

over the entire range of input voltages.

CHARACTERISATION OF THE INVENTION

To overcome the problems outlined above a switched power supply converter for a broad range of input voltages is proposed which is of ideal dimensions and electrical operating characteristics for supplying telecommunications systems with electrical power equal to or greater than 100 W.

An object of the switched power supply converter of the invention is to provide a converter that works with a very broad voltage range, for example 38 to 380 V (10:1), with simple overall operation and high overall performance. The power supply converter is implemented by means of two conversion stages connected in cascade. Both stages are implemented by means of straightforward, highly efficient conversion topologies.

A further object is that both conversion stages have a control circuit for regulating respectively their output voltage, the regulation processes being independent of each other.

The control circuit for the first stage regulates the duty cycle of a switching element of the first stage in the event that the input voltage lies within a predetermined range of input voltages, and when the input voltage is outside said range, the duty cycle is set to a value so that the output voltage of the first stage is proportional to the input voltage. As a consequence, the range of input voltages of the second stage is less than the range of input voltages of the first stage. Then, it is possible to optimise the operation of the components of the second stage, in particular for boosting its efficiency.

The switched power supply converter for broad range of input voltages of the invention is divided into a first stage that converts a first voltage supplied from a voltage source into a second voltage by means of a first switching element; a second stage receives the second voltage and transforms it into a third DC voltage.

A control circuit controls the duty cycle of the first switching element so that the duty cycle varies between a first limit of the duty cycle and a second limit of the duty cycle when the first voltage is within a predetermined range of voltage values. The control circuit sets the duty cycle to the first limit of the duty cycle or to the second limit of the duty cycle in the event that

the first voltage lies outside the predetermined range of voltage values.

BRIEF DESCRIPTION OF THE FIGURES

A more detailed explanation of the invention is given in the following description, based on the attached figures, in which:

- 5 - figure 1 shows a block diagram of a preferred embodiment of a switched power supply converter according to the invention.

DESCRIPTION OF THE INVENTION

Figure 1 shows a block diagram of a preferred embodiment of a switched power supply converter for broad range of input voltages. The power supply converter has a first stage 11 and a second stage 21 connected in cascade.

The first stage 11 of the power supply converter is connected to a power supply source via some input terminals 11-1 and 11-2, which correspond to the input terminals of the power supply converter. For example, the terminal 11-1 is connected to the positive pole and the terminal 11-2 to ground, respectively.

The first stage 11 is adapted to convert a broad range of input voltage values, first input voltage, into a predetermined range of output voltage, second output voltage, across some output terminals 12-1 and 12-2, which correspond to some input terminals of the second stage 21. Thus, this second voltage is directly fed to the input of the second stage 21.

The values that are possible for the second output voltage of the first stage 11 to adopt are such that they permit the stress level to be low in some switching elements included in the second stage 21, and also prevents them from having to support a high current spike.

It is possible to select different conversion topologies both for the first stage 11 and for the second stage 21, all of said topologies being known in the state of the art.

In a first embodiment for the first stage 11 a conversion topology without galvanic isolation is chosen, which is highly efficient and of straightforward operation; and for the second stage 21 a conversion topology is chosen that has a transformer T. In this manner, the second stage 21 provides galvanic isolation between the input and output of the switched power supply converter, permits the power supply converter to be designed with various outputs, as well as compliance with safety standards.

The first stage 11 comprises at least a first switching element 11-3, such as a field-effect transistor MOSFET, in order to perform the chopping of the first voltage applied across the input terminals 11-1 and 11-2; and produces across its output terminals 12-1 and 12-2 the second voltage, through the control of the duty cycle of the first switching element 11-3.

The regulation process of the second voltage is achieved by varying the duty cycle of the first switching element 11-3 by means of a control circuit 11-9, for example a pulse width modulation device, which includes a control logic to carry out missions such as regulation of the second voltage, limitation of the duty cycle of the first switching element 11-3, and others.

It is possible for the duty cycle to be limited to a maximum duty cycle (first limit of the duty cycle) or to a minimum duty cycle (second limit of the duty cycle).

The first stage 11 regulates the second voltage by means of the control circuit 11-9 in the event that the value of the first input voltage applied across its terminals 11-1 and 11-2 is within a predetermined voltage range, i.e., the control circuit 11-9 produces a duty cycle which is within a predetermined range of the duty cycle, which is defined by means of the first limit and the second limit of the duty cycle, so that the second voltage applied across the output terminals 12-1 and 12-2 is stabilised.

However, when the value of the input voltage applied across the terminals 11-1 and 11-2 is above or below the predetermined voltage range, the control circuit 11-9 generates a constant duty cycle, the value of which coincides with one of the limits of the predetermined range of the duty cycle, i.e., the first stage 11 does not regulate its output voltage, merely generates the voltage corresponding to one of the limits of the duty cycle (maximum duty cycle or minimum duty cycle). The control circuit 11-9 sets the limit of the duty cycle by means of its control logic.

In brief, the first stage 11 regulates the second output voltage for a range of the first input voltage and for values of input voltage outside this voltage range the first stage 11 produces across its output terminals 12-1 and 12-2 a second voltage proportional to the first input voltage.

In both situations, the second voltage present across the terminals 12-1 and 12-2 is such that it permits the stress level to be low in the switching elements of the second stage 21, and also prevents them from

- 5 -

having to support a high current spike.

The embodiment of the first stage 11 is possible by means of different conversion topologies without galvanic isolation such as a buck converter or a boost converter. The converters without galvanic isolation are implemented with a minimum of components implying that it is a converter free of operational complexity. In both topologies the transfer of energy is performed inductively since it can be considered that the connection between the input and the output is achieved via an inductor through the first switching element 11-3.

10 The second stage 21 is adapted to transform the second voltage into a third voltage by the action of a transformer T. Then, it is possible to implement said stage 21 according to different conversion topologies with galvanic isolation such as a forward converter with active clamp or a flyback converter. Both converters have the property of including galvanic isolation, however the latter is mounted in a different position. The galvanic isolation is provided by means of the transformer T.

Therefore, the second stage 21 provides galvanic isolation between the input and the output of the switched power supply converter; additionally, with a simple change of turns ratio a change between a step-down and a step-up output is facilitated and it is also possible to provide various outputs for the switched power supply converter.

It is also possible to achieve a change of polarity in the output voltage by merely changing the wiring of transformer T. Before the transformed voltage reaches the load, it has to be filtered to produce the third stabilised voltage, which shall correspond to the output of the converter. The second stage 21 performs the regulation of the third voltage by means of a second control circuit that extracts a sample of the third voltage.

The topologies mentioned above are known in the state of the art, consequently their operation is not explained herein. The first stage 11 and the second stage 21 of the switched power supply converter can be implemented according to other conversion topologies.

The switched power supply converter of the invention has a high overall efficiency and its operation is straightforward, in spite of having two conversion stages 11 and 21, with their corresponding control loops, which are independent.

- 6 -

By means of a rectifier bridge, the input terminals 11-1 and 11-2 of the switched power supply converter are connected to an AC voltage source.

CLAIMS

1. - **Switched power supply converter for broad range of input voltages** that comprises a first stage (11) which converts a first voltage supplied from a voltage source into a second voltage by means of a first switching element (11-3) and a second stage (21) that receives the second voltage and transforms it into a third DC voltage, **characterised** in that a first control circuit (11-9) controls the duty cycle of the first switching element (11-3) so that the duty cycle varies between a first limit of the duty cycle and a second limit of the duty cycle when the first voltage is inside a predetermined range of voltage values.

2. - **Switched power supply converter** according to claim 1, **characterised** in that the first control circuit (11-9) sets the duty cycle at the first limit of the duty cycle or at the second limit of the duty cycle in the event that the first voltage is outside the predetermined range of voltage values.

3. - **Switched power supply converter** according to claim 2, **characterised** in that the first control circuit (11-9) takes a sample of the second voltage.

4. - **Switched power supply converter** according to claim 3, **characterised** in that the first control circuit (11-9) is added to the first stage (11).

5. - **Switched power supply converter** according to claim 1, **characterised** in that the first stage (11) is implemented according to a conversion topology without galvanic isolation.

6. - **Switched power supply converter** according to claim 1, **characterised** in that the second stage (21) is implemented according to a conversion topology with galvanic isolation.

7. - **Switched power supply converter** according to claim 6, **characterised** in that the second stage (21) comprises a transformer (T) with a predetermined number of secondary windings that configure a predetermined number of outputs of the switched power supply converter, respectively.

8. - **Switched power supply converter** according to claim 1, **characterised** in that a second control circuit takes a sample of the third voltage to perform the regulation of the third voltage.

9. - **Switched power supply converter** according to claim 8,

- 8 -

characterised in that the second stage (21) comprises the second control circuit.

10. - Switched power supply converter according to any of claims 1 and 8, **characterised** in that the first control circuit and the second control
5 circuit are independent.

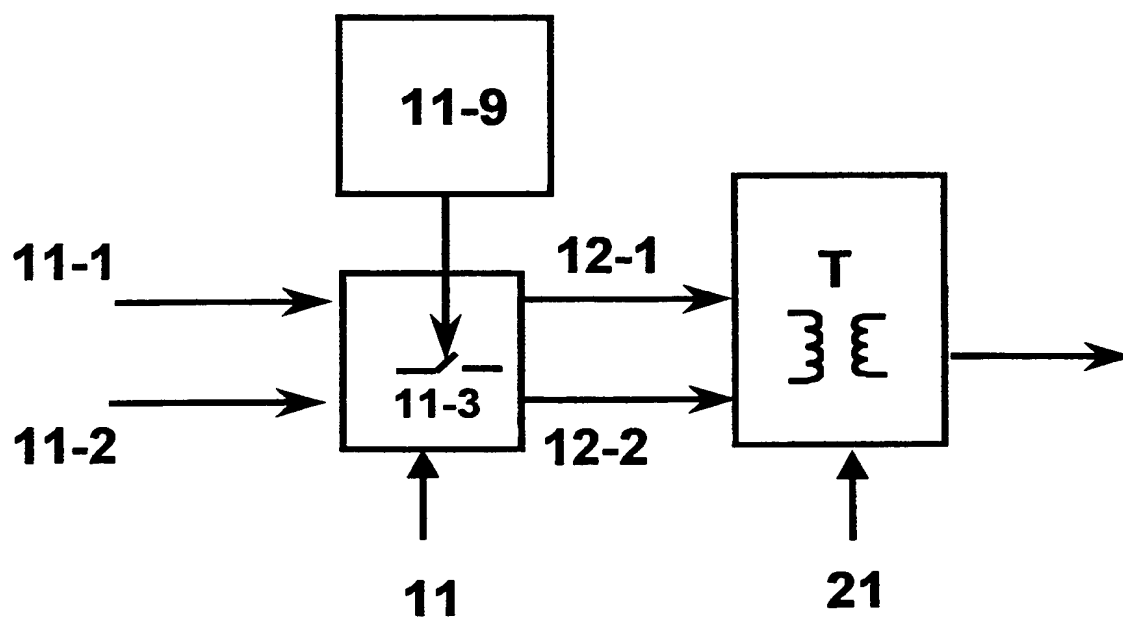


FIG. 1

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/EP 00/10104

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02M3/335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 006 782 A (PELLEY BRIAN R) 9 April 1991 (1991-04-09) the whole document	1, 5, 10
X	US 5 570 276 A (CUK SLOBODAN ET AL) 29 October 1996 (1996-10-29) the whole document	1, 5-10
A	US 5 414 342 A (MAMMANO ROBERT A ET AL) 9 May 1995 (1995-05-09) the whole document	1
X	US 5 394 076 A (HUYKMAN RICHARD B) 28 February 1995 (1995-02-28) the whole document	1, 5

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
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- *P* document published prior to the international filing date but later than the priority date claimed

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- *X* document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

2 March 2001

Date of mailing of the international search report

12/03/2001

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 00/10104

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5006782	A	09-04-1991	NONE	
US 5570276	A	29-10-1996	NONE	
US 5414342	A	09-05-1995	NONE	
US 5394076	A	28-02-1995	NONE	

10/089797
JC10 Rec'd PCT/PTO 04 APR 2002

ARTICLE 34 AMENDMENTS
TO SPECIFICATION AND CLAIMS

REPLACED BY
ART 34 AMST

1/p RTS

10/089797
JC10 REG PCT/PTO 04 APR 2002

- 1 -

SWITCHED POWER SUPPLY CONVERTER FOR BROAD RANGE OF INPUT VOLTAGES

OBJECT OF THE INVENTION

The present invention relates to a switched power supply converter
5 that comprises at least one switching element with which the transfer of
energy between the input and the output of the power supply converter is
governed.

The switching element is controlled so that its duty cycle is at all times
a function of the value of the output voltage, whereby the power supply
10 converter offers a high efficiency over a universal range of input voltages.

The switched power supply converter is of special, but not exclusive
application in telecommunications systems, which are fed from voltage
sources of 38 to 380 V.

STATE OF THE ART

15 A switched power supply converter which has a switching element
whose duty cycle is variable and which receives a broad range of input
voltages has been described, for example, in the US Patent 5,856,739
granted to A. Trica, incorporated in the present patent application by
reference.

20 The switched converter, implemented according to a buck topology,
comprises a switching element that has a high switching frequency and a
variable duty cycle, an internal control current loop, an external control
voltage loop and a control circuit that controls the duty cycle of the switching
element as a function of the current loop and of the voltage loop.

25 The power supply converter accepts a broad range of input voltages
of up to four times the output voltage. The converter is capable of working in
voltage ranges that include voltage values supplied from batteries and from
alternating current supply sources. However it is incapable of working with
higher ranges, for example 10:1, and providing power levels equal to or
30 greater than 100 W.

It has become necessary to develop a switched power supply
converter that accepts a universal range of input voltages, which includes
the voltage values supplied normally by the batteries of telecommunications
systems, and guarantees for all of them the provision of a constant and
35 regulated voltage at its output, so that the converter offers a high efficiency

CLAIMS

1. - **Switched power supply converter for broad range of input voltages** that comprises a first stage (11) which converts a first voltage supplied from a voltage source into a second voltage by means of a first switching element (11-3) and a second stage (21) that receives the second voltage and transforms it into a third DC voltage, **characterised** in that a first control circuit (11-9) controls the duty cycle of the first switching element (11-3) so that the duty cycle varies between a first limit of the duty cycle and a second limit of the duty cycle when the first voltage is inside a predetermined range of voltage values.

2. - **Switched power supply converter** according to claim 1, **characterised** in that the first control circuit (11-9) sets the duty cycle at the first limit of the duty cycle or at the second limit of the duty cycle in the event that the first voltage is outside the predetermined range of voltage values.

3. - **Switched power supply converter** according to claim 2, **characterised** in that the first control circuit (11-9) takes a sample of the second voltage.

4. - **Switched power supply converter** according to claim 3, **characterised** in that the first control circuit (11-9) is added to the first stage (11).

5. - **Switched power supply converter** according to claim 1, **characterised** in that the first stage (11) is implemented according to a conversion topology without galvanic isolation.

6. - **Switched power supply converter** according to claim 1, **characterised** in that the second stage (21) is implemented according to a conversion topology with galvanic isolation.

7. - **Switched power supply converter** according to claim 6, **characterised** in that the second stage (21) comprises a transformer (T) with a predetermined number of secondary windings that configure a predetermined number of outputs of the switched power supply converter, respectively.

8. - **Switched power supply converter** according to claim 1, **characterised** in that a second control circuit takes a sample of the third voltage to perform the regulation of the third voltage.

9. - **Switched power supply converter** according to claim 8,

characterised in that the second stage (21) comprises the second control circuit.

5 **10. - Switched power supply converter** according to any of claims 1 and 8, **characterised** in that the first control circuit and the second control circuit are independent.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 129185	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/EP 00/ 10104	International filing date (day/month/year) 02/10/2000	(Earliest) Priority Date (day/month/year) 05/10/1999
Applicant ALCATEL		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1

☐ None of the figures.

12 MAR. 2001

PATENT COOPERATION TREATY

Payer ex

5/4/2003

Meta en m/s-p

PCT Entries ending

From the INTERNATIONAL SEARCHING AUTHORITY

To:

ALCATEL ESPANA, S.A.
Patent Department
Attn. LAMOUREUX, Bernard
Ramirez de Prado, 5
ES-28045 Madrid
SPAIN

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT
OR THE DECLARATION

(PCT Rule 44.1)

Podar ~~examined~~ 05/05/01
deadline

Date of mailing
(day/month/year)

12/03/2001

Applicant's or agent's file reference

129185

FOR FURTHER ACTION

See paragraphs 1 and 4 below

International application No.

PCT/EP 00/ 10104

International filing date
(day/month/year)

02/10/2000

Applicant

ALCATEL

1. ☒ The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Fascimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Shantisaroop Pherai

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 129185	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/EP 00/ 10104	International filing date (day/month/year) 02/10/2000	(Earliest) Priority Date (day/month/year) 05/10/1999
Applicant ALCATEL		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

1



as suggested by the applicant.



None of the figures.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International Application No

P/EP 00/10104

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 H02M3/335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 H02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 006 782 A (PELLEY BRIAN R) 9 April 1991 (1991-04-09) the whole document ---	1,5,10
X	US 5 570 276 A (CUK SLOBODAN ET AL) 29 October 1996 (1996-10-29) the whole document ---	1,5-10
A	US 5 414 342 A (MAMMANO ROBERT A ET AL) 9 May 1995 (1995-05-09) the whole document ---	1
X	US 5 394 076 A (HUYKMAN RICHARD B) 28 February 1995 (1995-02-28) the whole document -----	1,5



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

* & * document member of the same patent family

Date of the actual completion of the international search

2 March 2001

Date of mailing of the international search report

12/03/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

Authorized officer

Thisse, S

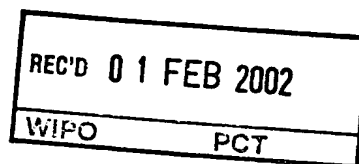
INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 00/10104

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5006782	A	09-04-1991	NONE	
US 5570276	A	29-10-1996	NONE	
US 5414342	A	09-05-1995	NONE	
US 5394076	A	28-02-1995	NONE	



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference ----	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP00/10104	International filing date (day/month/year) 02/10/2000	Priority date (day/month/year) 05/10/1999
International Patent Classification (IPC) or national classification and IPC H02M3/335		
Applicant ALCATEL et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 27/04/2001	Date of completion of this report 30.01.2002
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Kern, H Telephone No. +49 89 2399 2266 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP00/10104

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

2-6	as originally filed			
1,1a-1b	as received on	01/10/2001	with letter of	20/09/2001

Claims, No.:

1-7	as received on	01/10/2001	with letter of	20/09/2001
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Drawings, sheets:

1/1	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP00/10104

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-7
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-7
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-7
	No:	Claims	

- 2. Citations and explanations
see separate sheet**

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The subject-matter of claim 1 concerns a switched power supply converter for broad range of input voltages which comprises a first and a second converter stage. The main problem underlying present matter is to provide a converter that works with a very broad voltage range with simple overall operation and high overall performance whereby the power supply is implemented by means of two conversion stages connected in cascade. To deal with the broad voltage range by a simple control scheme the application restricts the duty cycle of the first converter stage to first and second limits when the input voltage range is outside a predetermined range of voltage values, which leads to simple and stable voltage control scheme.

Prior art document US-A-5,006,782 discloses two or more buck converter circuit which are cascaded in such manner that the output of one serves as the input of the next, with the input voltage to each succeeding buck converter stage being reduced in magnitude. The first stage is designed to reduce input voltage of 450 volts to some constant value 80 volts. This is accomplished by continually adjusting the duty cycle of the switching transistor in the first stage. No measures are provided when the input voltage is outside the particular voltage range.

As the claimed measure can not be derived from prior art and obviously leads to a more stable control loop, the requirements of Article 33 PCT are met. The dependent claims concern advantageous embodiments of the invention.

2. The industrial applicability is obviously given.

SWITCHED POWER SUPPLY CONVERTER FOR BROAD RANGE OF INPUT VOLTAGES

OBJECT OF THE INVENTION

5 The present invention relates to a switched power supply converter that comprises at least one switching element with which the transfer of energy between the input and the output of the power supply converter is governed.

The switching element is controlled so that its duty cycle is at all times a function of the value of the output voltage, whereby the power supply converter offers a high efficiency over a universal range of input voltages.

10 The switched power supply converter is of special, but not exclusive application in telecommunications systems, which are fed from voltage sources of 38 to 380 V.

STATE OF THE ART

15 A switched power supply converter which has a switching element whose duty cycle is variable and which receives a broad range of input voltages has been described, for example, in the US Patent 5,856,739 granted to A. Trica, incorporated in the present patent application by reference.

20 The switched converter, implemented according to a buck topology, comprises a switching element that has a high switching frequency and a variable duty cycle, an internal control current loop, an external control voltage loop and a control circuit that controls the duty cycle of the switching element as a function of the current loop and of the voltage loop.

25 The power supply converter accepts a broad range of input voltages of up to four times the output voltage. The converter is capable of working in voltage ranges that include voltage values supplied from batteries and from alternating current supply sources. However it is incapable of working with higher ranges, for example 10:1, and providing power levels equal to or greater than 100 W.

30 In the US Pat 5,006,782 granted to Pelly, teaches a two or more buck converter circuits are cascaded in such a manner that the output of one serves as the input to the next, with the input voltage to each succeeding buck converter stage being reduced in magnitude.

35 The first stage of the buck converter containing a first switching transistor having an adjustable duty cycle to produce a nominally fixed output voltage. The output voltage of the first stage is lower than the minimum input

1-a

voltage but is higher than the desired final output voltage of the cascaded buck converter. The output voltage of the first stage forms the input voltage of the second stage. The switching transistor in the second stage has a nominally fixed duty cycle sufficient to reduce its input voltage, which corresponds to the output voltage of the first stage, to some fixed output voltage for the second stage.

The first stage is designed to reduce input voltage of 450 volts to some constant value 80 volts. This is accomplished by continually adjusting the duty cycle of the switching transistor in the first stage.

Unfortunately, when the input voltage is outside of the range between 450 volts and 80 volts, first stage does not teaches how is adjusting the duty cycle of the switching transistor in the first stage.

It has become necessary to develop a switched power supply converter that accepts a universal range of input voltages, which includes the voltage values supplied normally by the batteries of telecommunications systems, and guarantees for all of them the provision of a constant and regulated voltage at its output, so that the converter offers a high efficiency over the entire range of input voltages.

CHARACTERISATION OF THE INVENTION

To overcome the problems outlined above a switched power supply converter for a broad range of input voltages is proposed which is of ideal dimensions and electrical operating characteristics for supplying telecommunications systems with electrical power equal to or greater than 100 W.

An object of the switched power supply converter of the invention is to provide a converter that works with a very broad voltage range, for example 38 to 380 V (10:1), with simple overall operation and high overall performance. The power supply converter is implemented by means of two conversion stages connected in cascade. Both stages are implemented by means of straightforward, highly efficient conversion topologies.

A further object is that both conversion stages have a control circuit for regulating respectively their output voltage, the regulation processes being independent of each other.

The control circuit for the first stage regulates the duty cycle of a switching element of the first stage in the event that the input voltage lies within

1-b

a predetermined range of input voltages, and when the input voltage is outside said range, the duty cycle is set to a value so that the output voltage of the first stage is proportional to the input voltage. As a consequence, the range of input voltages of the second stage is less than the range of input
5 voltages of the first stage. Then, it is possible to optimise the operation of the components of the second stage, in particular for boosting its efficiency.

The switched power supply converter for broad range of input voltages of the invention is divided into a first stage that converts a first voltage supplied from a voltage source into a second voltage by means of a first switching
10 element; a second stage receives the second voltage and transforms it into a third DC voltage.

A control circuit controls the duty cycle of the first switching element so that the duty cycle varies between a first limit of the duty cycle and a second limit of the duty cycle when the first voltage is within a predetermined range of
15 voltage values. The control circuit sets the duty cycle to the first limit of the duty cycle or to the second limit of the duty cycle in the event that the first voltage lies outside the predetermined range of voltage values.

CLAIMS

- 1. Switched power supply converter for broad range of input voltages** that comprises a first stage (11) which converts a first voltage supplied from a voltage source into a second voltage by means of a first switching element (11-3) and a second stage (21) that receives the second voltage and transforms it into a third DC voltage, a first control circuit (11-9) controls the duty cycle of the first switching element (11-3) so that the duty cycle varies between a first limit of the duty cycle and a second limit of the duty cycle; **characterised** in that the first control circuit (11-9) is adapted to fix the duty cycle at the first limit of the duty cycle or at the second limit of the duty cycle in the event that the first voltage is outside a predetermined range of voltage values.
- 2. Switched power supply converter** according to claim 1, **characterised** in that the first control circuit (11-9) is adapted to receive a sample of the second voltage.
- 3. Switched power supply converter** according to claim 1, **characterised** in that the first stage (11) is implemented according to a conversion topology without galvanic isolation.
- 4. Switched power supply converter** according to claim 1, **characterised** in that the second stage (21) is implemented according to a conversion topology with galvanic isolation.
- 5. Switched power supply converter** according to claim 5, **characterised** in that the second stage (21) comprises a transformer (T) with a predetermined number of secondary windings that configure a predetermined number of outputs of the switched power supply converter, respectively.
- 6. Switched power supply converter** according to claim 6, **characterised** in that the second stage (21) comprises a second control circuit that is adapted to receive a sample of the third voltage and regulates the third voltage.
- 7. Switched power supply converter** according to any of claims 1 and 6, **characterised** in that the first control circuit and the second control circuit are independent.